Journal of Cardiovascular Magnetic Resonance
BioMed Central

Poster presentation

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The value of MRA images for identifying intraplaque hemorrhage in carotid plaque

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from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):P132 doi:10.1186/1532-429X-12-S1-P132

This abstract is available from: http://jcmr-online.com/content/12/S1/P132

Introduction

MR angiography (MRA) has become a standard workup for carotid atherosclerosis, using either contrast-enhanced (CE) or time-of-flight (TOF) techniques. This provides a measure of narrowing but does not identify plaque components that indicate risk of rupture, such as the presence of intraplaque hemorrhage (IPH). CE and TOF techniques employ highly T1-weighted 3D gradient-echo sequences, and have the potential to detect IPH because of T1 short blood products.

Purpose

We sought to determine whether IPH can be detected using either TOF or pre-contrast CEMRA (mask) images alone as part of the standard MRA workup, and if so, which is more reliable and accurate.

Methods

Carotid MRA scans were performed at 3 T on 10 patients (age range = 58-86 y, 80% male) scheduled for carotid endarterectomy (CEA) for stenosis. A 3D TOF MRA was acquired with the following parameters: TR/TE/flip angle, 23 msec/3.5 msec/25°; voxel size, 0.6 × 0.8 × 1 mm. A CEMRA was acquired before (mask image) and after contrast administration with the following parameters: TR/TE/flip angle, 6.0 msec/2.0 msec/30°; voxel size, 0.7 × 0.7 × 1 mm. The source images of both MRA sequences were reconstructed to a transverse plane. CEA specimens were matched to the MRI images and stained with glycophorin A and Mallory's stain to detect IPH. MR images were de-identified and reviewed randomly by two independent readers for IPH presence (identified as hyperintense regions compared to adjacent muscle (1)). The sensitivity, specificity, positive and negative predictive values (PPV and NPV) for IPH detection were calculated. Inter- and intra-observer agreements were determined by Cohen's kappa statistics.

Results

The median stenosis was 77.5% (range, 60%-99%). Five of 10 CEA specimens (41 of 99 MRI images) contained contained IPH confirmed by histology. Compared to TOF, CEMRA demonstrated higher diagnostic values, including sensitivity, specificity, PPV and NPV for IPH by two independent readers (Table 1). The accuracy rate for correctly identifying IPH using CEMRA mask images and TOF images was 90.1% and 82.9%, respectively. Inter- and intra-observer agreements for IPH detection were excellent by mask images (κ = 0.87 and κ = 0.83, respectively) and were good by TOF images (κ = 0.79 and κ = 0.68 for inter- and intra-observer, respectively).

Conclusion

CEMRA mask images are highly accurate and reliable for identifying IPH, more so than the TOF sequence, and can provide valuable information about risk for rupture.

Table 1: Comparison of two MRA techniques for IPH detection

MRA techniques	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	
CEMRA-MASK	Reader 1	92.7	96.6	95.0	94.9
	Reader 2	87.8	96.6	94.7	91.8
TOF	Reader 1	85.3	84.5	79.5	89.1
	Reader 2	80.5	85.4	80.5	85.5

References

1. Moody AR, *et al.*: **Circulation. 107(24):**3047-52.